

CLAIMS

1. A piece of drilling equipment made by the steps comprising:
 - a. placing a device having a device temperature within a thermal control apparatus comprising a chamber comprising a chamber temperature;
 - 5 b. introducing a first cryogenic material into the thermal control apparatus to decreasing the device temperature and while preventing over-stressing of the device, to a first target temperature ranging from -40 degrees F to -380 degrees F at a first temperature rate ranging from 0.25 degrees F per minute to 20 degrees F per minute;
 - 10 c. stopping the introduction of the cryogenic material into the chamber once the first target temperature is reached;
 - d. increasing the chamber temperature to a second target temperature ranging from 0 degrees F to 1400 degrees F;
 - 15 e. increasing the device temperature to the second target temperature at a second temperature rate ranging from 0.25 degrees F per minute to 20 degrees F per minute resulting in an intermediate device having an intermediate device temperature;
 - 20 f. introducing a second cryogenic material into the thermal control apparatus to decreasing the intermediate device temperature while preventing over-stressing of the intermediate device, to a third target temperature ranging from -40 degrees F to -380 degrees F at a third temperature rate ranging from 0.25 degrees F per minute to 20 degrees F per minute;
 - g. increasing the chamber temperature to a fourth target temperature ranging from 0 degrees F to 1400 degrees F; and

- h. causing the intermediate device temperature to increase to the fourth target temperature at a fourth temperature rate ranging from 0.25 degrees F per minute to 20 degrees F per minute resulting in a treated device without fractures.
- 2. The drilling equipment of claim 1, wherein the device is selected from the group consisting of drill bits, pumps, engines, levers, actuator arms, bearings, cams, lifters, valves, engines, and combinations thereof.
- 3. The drilling equipment of claim 1, wherein the first temperature rate is different from the second temperature rate to create a desired metallurgical characteristic in the treated device, wherein the characteristic is selected from the group consisting of wear-resistance, impact resistance, ductility, hardness, strength and combinations thereof.
- 4. The drilling equipment of claim 1, wherein the device is treating using a first temperature rate substantially the same as the second temperature rate.
- 5. The drilling equipment of claim 1 wherein the intermediate device is treated further using the steps of:
 - a. introducing a third cryogenic material into the thermal control apparatus to decreasing the intermediate device temperature while preventing over-stressing of the intermediate device, to a fifth target temperature ranging from -40 degrees F to -380 degrees F at a fifth temperature rate ranging from 0.25 degrees F per minute to 20 degrees F per minute;
 - b. increasing the chamber temperature to a sixth target temperature from 0 degrees F to 1400 degrees F; and
 - c. increasing the intermediate device temperature to the sixth target temperature at a sixth temperature rate ranging from 0.25 degrees F per minute to 20 degrees F per minute resulting in treated device without fractures.
- 6. The drilling equipment of claim 1, further comprising the step of permitting the device to soak at the first target temperature for a first period of time.

7. The drilling equipment of claim 9, wherein the first period of time ranges from 15 minutes to 96 hours.
8. The drilling equipment of claim 1, further comprising the step of permitting the intermediate device to soak at the second target temperature for a second period of time that ranges from 15 minutes to up to 48 hours.
9. The drilling equipment of claim 1, wherein the thermal control apparatus further comprises a heat exchanger.
10. The drilling equipment of claim 1, wherein the cryogenic material is a member of the group consisting of hydrogen, nitrogen, oxygen, helium, argon, and combinations thereof.
- 10 11. The drilling equipment of claim 1, wherein the first temperature rate, the second temperature rate, the third temperature rate and the fourth temperature rate and are determined by the mass of the device.
12. The drilling equipment of claim 1, wherein the device is used to drill, cut, shape, gouge, rasp, or abrade materials selected from the group consisting of wood, ceramic, metal, plastic, composite material, and combinations thereof.